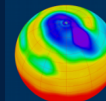




The CMIP6 Data Request – with overview of IPCC process

Martin Juckes

March 2018



International consensus

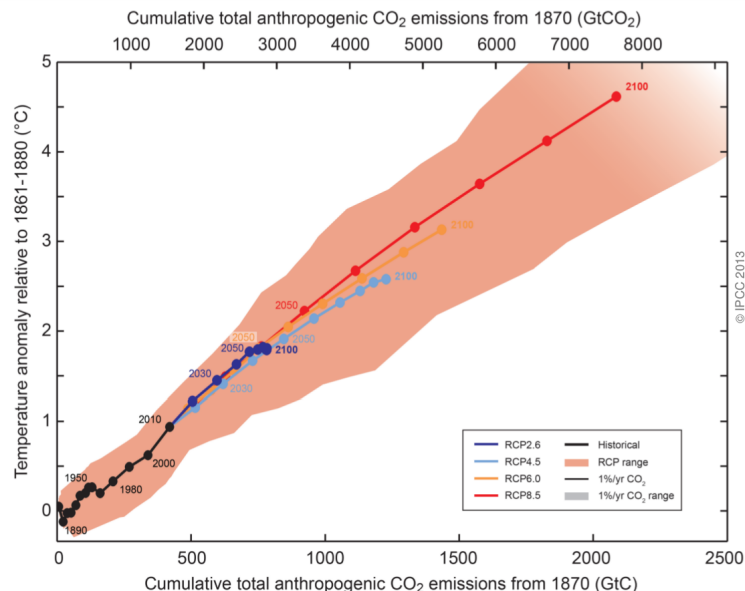


Assessing the research literature



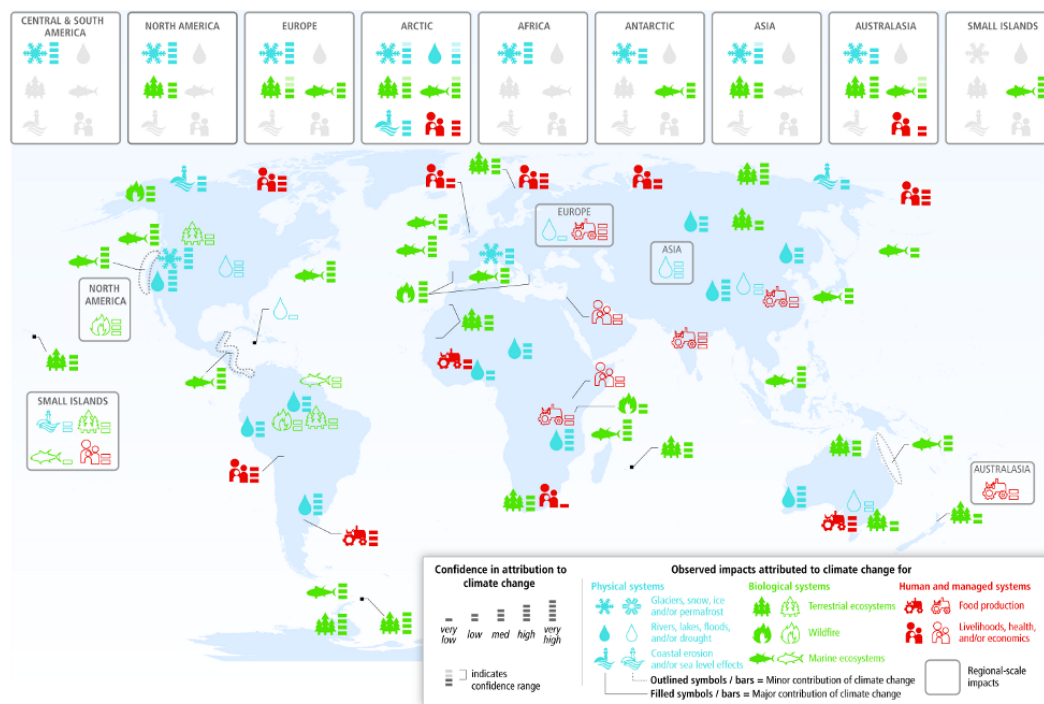


From IPCC 5th Assessment Report



Clear relation between accumulated CO₂ emissions and global temperature

Evidence of impacts on environment and society

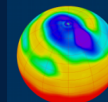




CMIP and the IPCC

CMIP is independent of the IPCC process ...

But CMIP provides the foundations for the IPCC report on the physical basis of climate change, and modelling groups are strongly motivated by a desire to meet the deadlines for inclusion of results in the current IPCC assessment cycle.





CMIP5

Volume: 2.3Pb

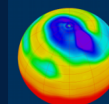
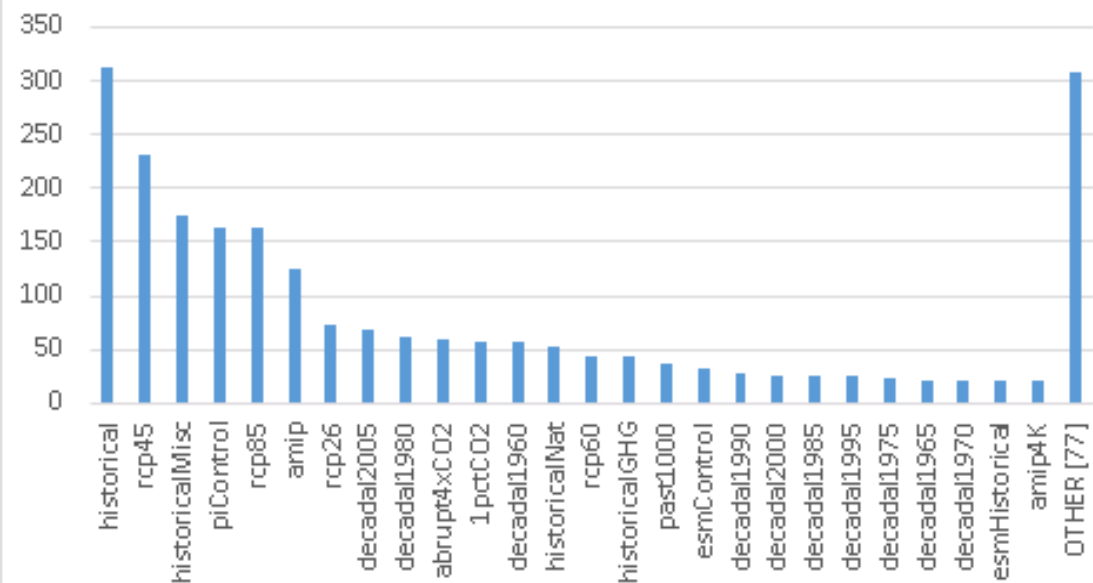
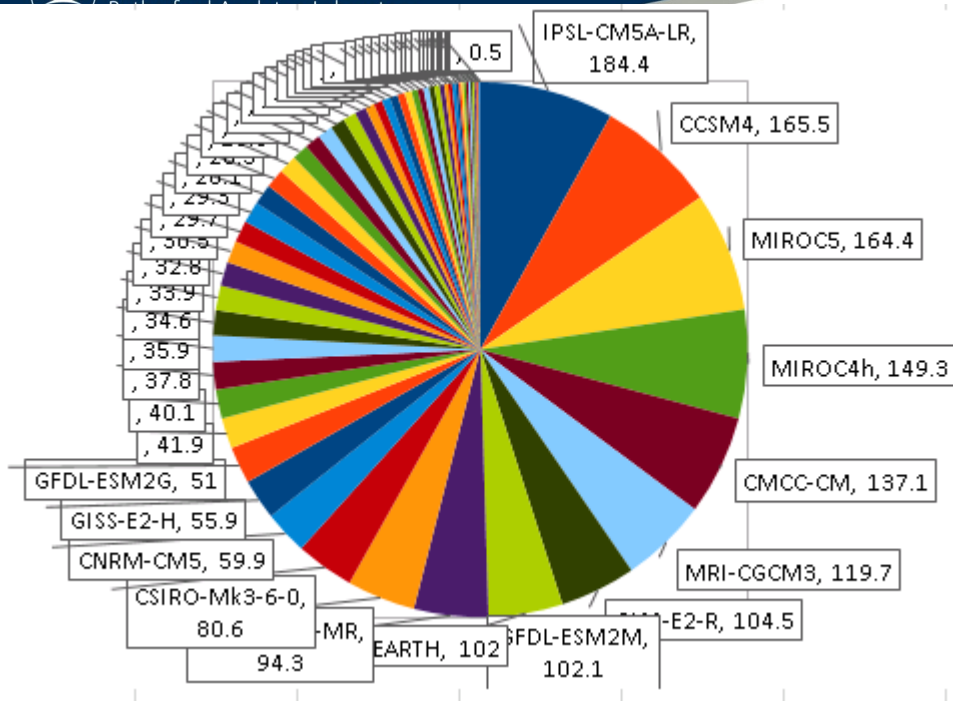
27 Institutions contributing data;
100 Experiments

Major input to AR5

CMIP3: 30Tb

CMIP5: 2.3Pb

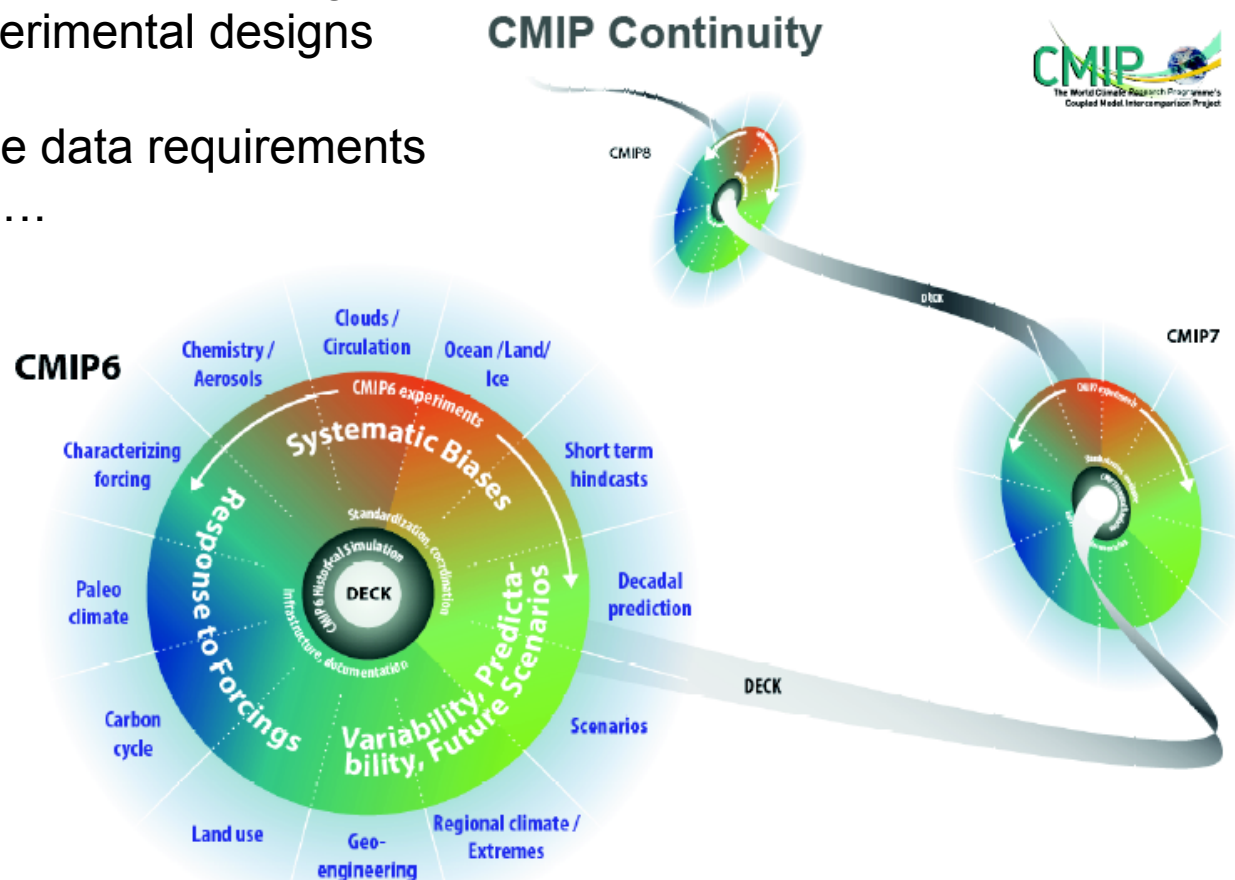
CMIP6: $\sim 2 \times 10^{16 \pm 0.8}$ Bytes





CMIP6 introduces an ambitious new organisational structure to cope with the rapidly expanding scope of climate modelling: 21 different science consortia developing research objectives, experimental designs and data requirements.

WCRP mandated that the data requirements should be consolidated





Organising data

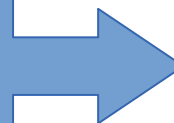
for the Coupled Model Inter-comparison Project (CMIP)

CMIP
Panel

WGCM
Infrastructure
Panel

21 endorsed Model
Inter-comparison
Projects dealing with
different science areas.
Science objectives and
experimental outlines
published in GMD

Data
requirements
for each MIP



Consolidated data
request: > 2000 variables,
various frequencies, grids,
masks and tiles.



~30 modelling centres will participate, each
supporting one or more of the endorsed MIPs. All
centres should complete the “DECK” experiments:
historical, control, steady and abrupt CO2 increase.



The Endorsed MIP Constellation

ScenarioMIP: Scenarios

DAMIP: Detection-Attribution

GeoMIP: Geoengineering

VIACS AB: Vulnerability etc

CMIP: core

PMIP: Palaeoclimate

CORDEX: Downscaling

DCPP: Decadal

LS3MIP: Land Surface

LUMIP: Land Use

C4MIP: Carbon Cycle

HighResMIP: High Resolution

DynVar: Dynamic Variability

RFMIP: Radiative Forcing

CFMIP: Cloud Feedback

GMMIP: Monsoons

OMIP: Ocean

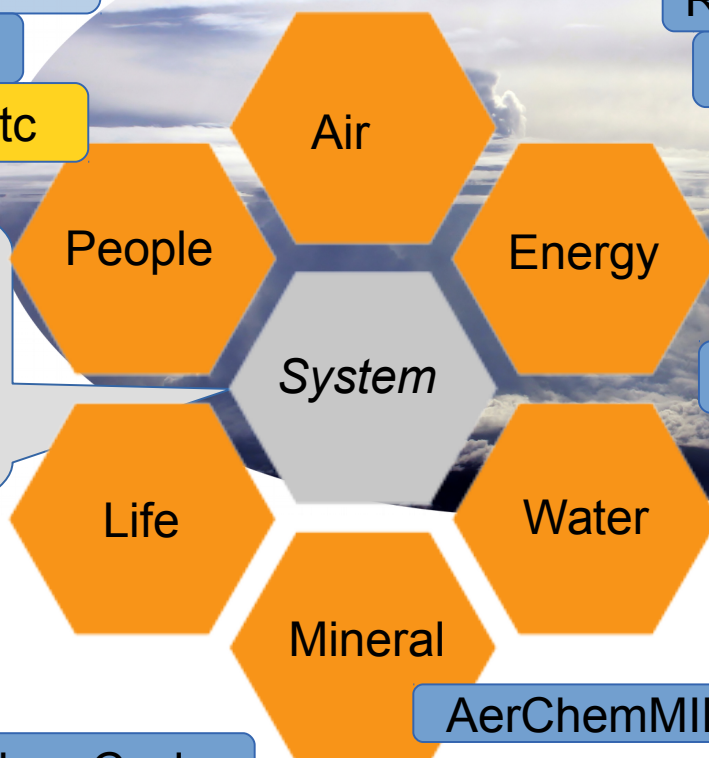
FAFMIP: Flux Anomalies

ISMIP6: Ice Sheet

SIMIP: Sea Ice

AerChemMIP: Aerosols and Chemistry

VolMIP: Volcanoes





Data Request: Target Users

Infrastructure
provider
(technician)

Infrastructure
provider
(manager)

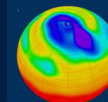
Data provider
(programme
manager)

Data provider
(technician)

Data provider
(scientist)

Data user (outside
modelling centres)

Data user (in
modelling centres)





Variable Lists

- Definition of physical quantities;
- Output specifications.

Recommendations for
output and analysis

Output Requirements

- Experiments and time slices
- Objectives supported
- Priority of variable

**CMIP6
Data
Request**

Experiment Specifications

- Duration of simulation
- Tier
- Number of ensemble members



The Software Architecture Components

Consolidated Request

The request as a structured document.

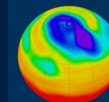
Programming Interface

A python library, facilitating use of the request by software.

Command Line

For flexible access

Web Access

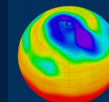




Greater flexibility

Modelling groups will select

- *priority of variables (as for CMIP5);*
- *which MIPs to support;*
- *objectives within MIPs;*
- *Tiers of experiments;*
- *MIPs can specify groups of variables; variables may be given different priorities for different experiments.*





Variable Lists

CMIP5

“standard output” spreadsheet: list of variables organised into MIP tables, 1098 CMOR variables, 536 standard names

CMIP6

~800 standard names

~1000 MIP Variable

~2000 CMOR Variables

~3500 Request Variables

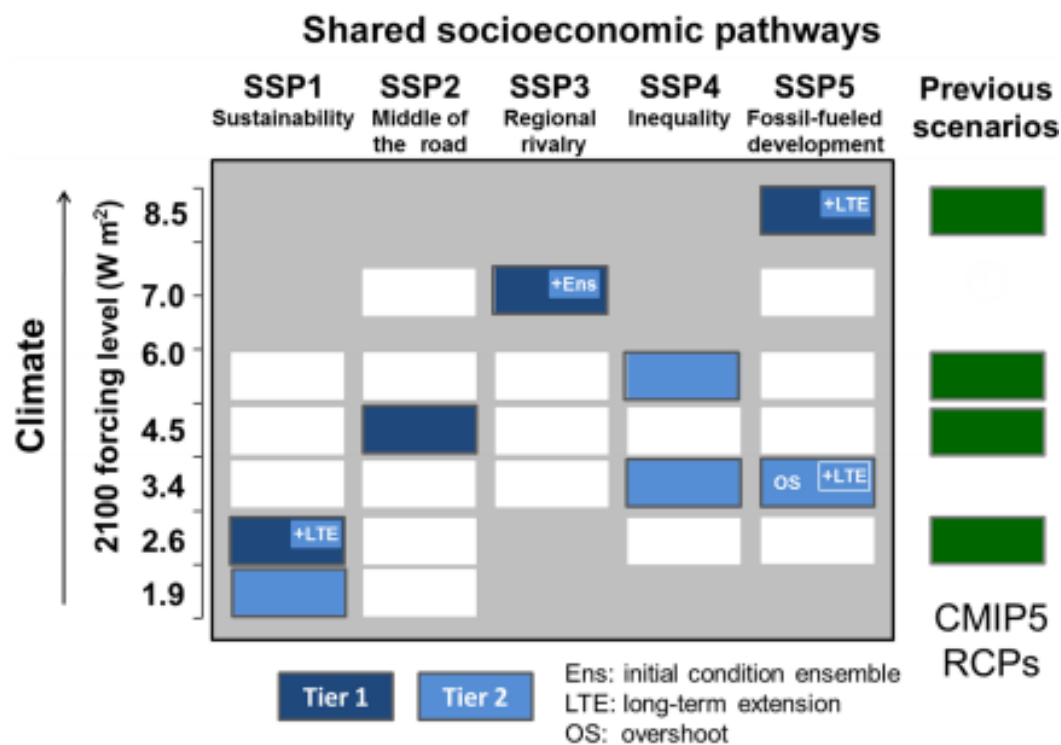
A “MIP Variable” can be re-used at different frequencies, or with different masking options.

A CMOR variable can be re-used at different priorities or in different groups.





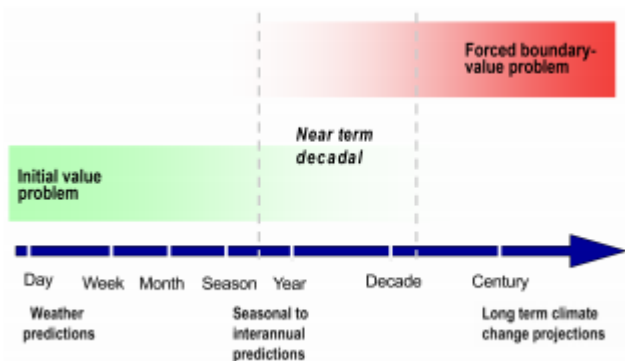
ScenarioMIP



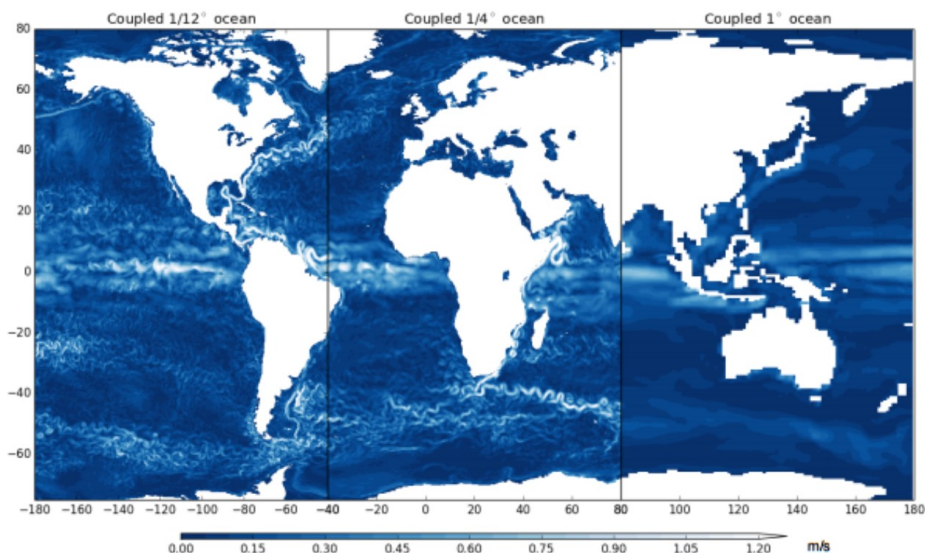
The 4 Representative Concentration Pathways of CMIP5 are replaced by a matrix of Shared socio-economic pathways.



Focussing on processes



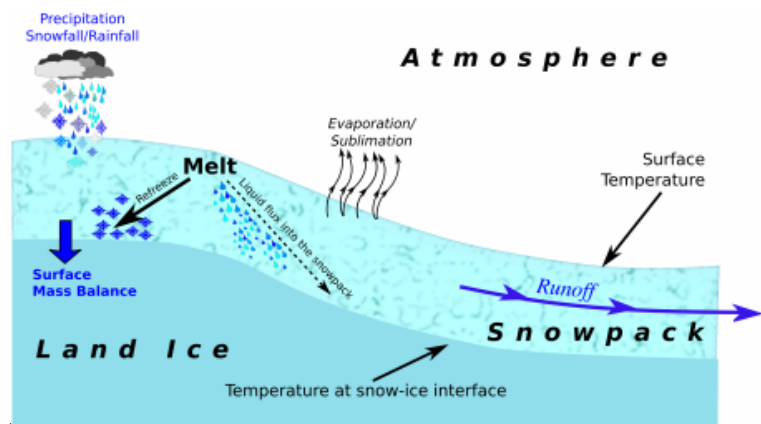
Decadal Climate Prediction Project (DCPP) ... looking at the boundary between forced centennial projections and seasonal forecasts.



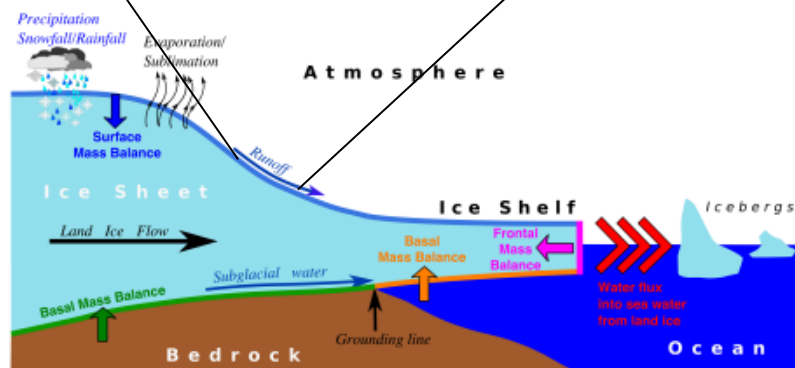
High Resolution MIP (HighresMIP) ... analysing climate change in high resolution models (fig. from H2020 project PRIMAVERA).



Advances in the cryosphere: ISMIP6



Detailed modelling of snowpack



Dynamic, floating, ice fronts



VIACSAB

Vulnerability, Impacts, Adaptation and Climate Services Advisory Board

Agriculture

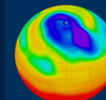
Terrestrial Ecosystems

Marine Ecosystems

Health

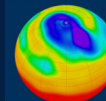
Fisheries

Climate Services





- *The end ...*





Variable Lists

Different MIPs may request the same variable with different priorities

- MIP
- Priority



*e.g. tas,
Amon,
PMIP*



*e.g. tas,
Amon*

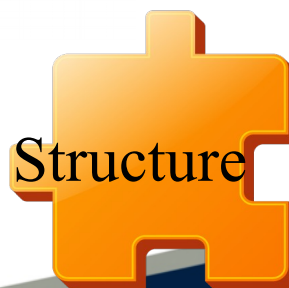
- short name
- standard name
- long name
- description
- units



e.g. tas

- CMOR name
- description
- frequency
- MIP table
- realm
-

A variable may occur in many different guises



- dimensions

- cell_methods
- cell_measures
- flag_meanings
- flag_values

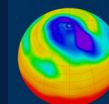


Use in python code:

```
from dreqPy import scope  
sc = scope.dreqQuery()  
v1 = sc.volByMip( 'C4MIP', pmax=2 )  
v2 = sc.volByMip( {'C4MIP', 'LUMIP'}, pmax=2 )
```

From the LINUX command line:

```
drq -m C4MIP,LUMIP -p 1 -t 1 → 24.17Tb  
drq -m HighResMIP -p 1 -t 1 → 45Tb  
drq -m HighResMIP:DiurnalCycle -p 1 -t 1 → 3.95 Tb
```



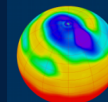


Variable choices

Requests conditional on model configuration.

Some variables are only needed for specific configurations/types of models. E.g.

- *time varying ice sheet state only needed for models with dynamic ice sheets;*
- *pressure on model levels not needed for models with pressure-based vertical coordinates;*

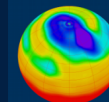




Ranked variables

Where there is clear redundancy between variables, e.g. air temperature on 7 pressure levels at 6 hourly intervals vs. the same variable on the same levels at 3 hourly intervals, these can be given a rank and the API will only select the highest ranked variable.

A modelling group supporting the HighResMIP request for priority 1 variables should provide the 6 hourly data, but another group going up to priority 2 will only supply the 3 hourly data.





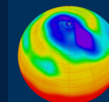
Problems ...

Preferred grid

If DCPD asks for data on a 100km grid and FAFMIP asks for the same data on the native grid, should both be considered as required?

Gaps in the request

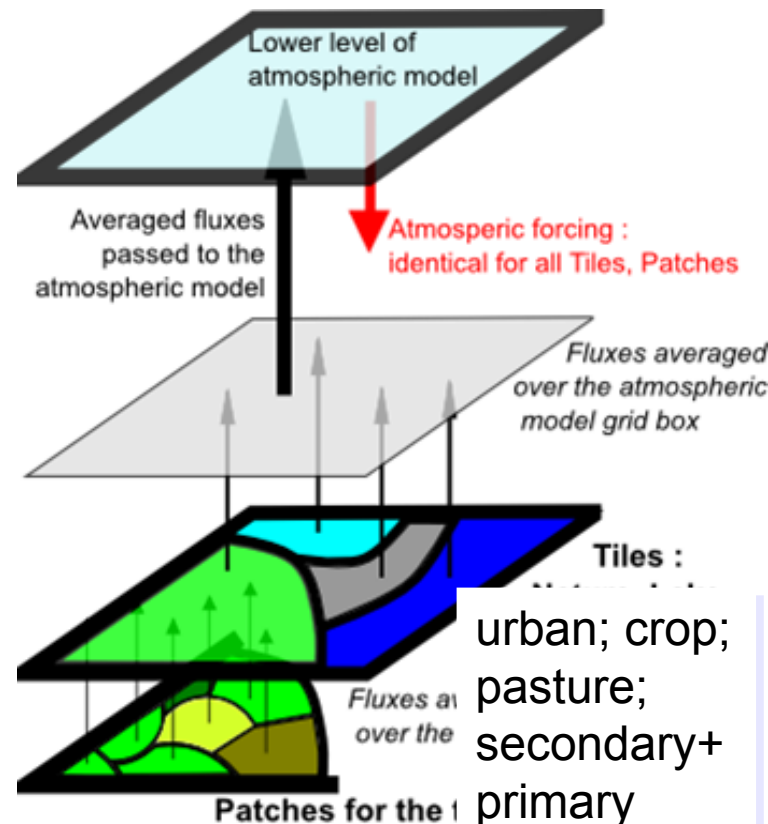
Only one MIP has requested “areacella” (the area of atmospheric grid cells). Should some fields be specified as required metadata? Are there other gaps?





CMIP6 Novelties

LUMIP is requesting output on four Land Use tiles which partially align with C4MIP vegetation fractions.

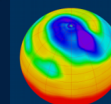
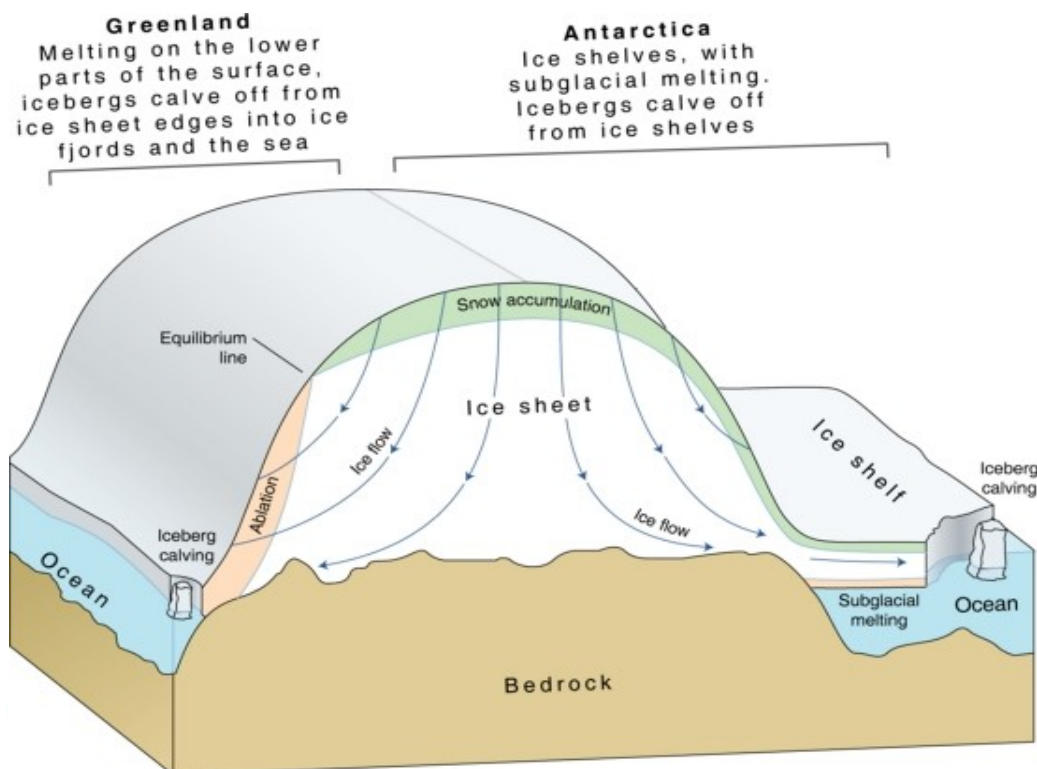


urban; crop;
pasture;
secondary+
primary

Adapted from MeteoFrance
<http://www.cnrm.meteo.fr/surfex/spip.php?rubrique8>

New area types and boundaries:

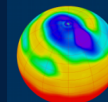
- surface under ice sheet
- grounding line





Resources

- *XML request document and documentation;*
- *Python library and documentation;*
- *Repository of document versions;*
- *Persistent identifiers (e.g. w3id.org/cmip6dr/variable/tas);*
- *Data request handbook (in preparation);*
- *Additional views of the request (excel, html, ...);*
- * forum: dreq01.vanillaforums.com*



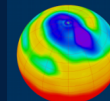


IPCC Numbers

831 Authors

6500 Pages

140000 Review comments





Output Request



Objective

- Objective
- Time slice
- Experiment group



Variable
Group

- MIP
- Priority



Request
Variable



Request
Link



Request
Item



Experiment
Set



Experiment

*e.g.
Amon,
PMIP,
amip*



ScenarioMIP Scenarios

Humanity

CORDEX: Downscaling inputs

Abstract

DAMIP Detection and Attribution

DCPP Decadal Climate Prediction

PMIP Palaeoclimate

GeoMIP Geoengineering

LUMIP Land Use

DECK: control experiments and model evaluation

VIACS AB Vulnerability, Impacts, ..

VolMIP Volcanic Forcings

Natural Ecosystems

Energy

LS3MIP Land Surface, Snow and Soil Moisture

C4MIP Coupled Climate Carbon Cycle

RFMIP Radiative Forcing

Earth

AerChemMIP: Aerosols and Chemistry

CFMIP Cloud Feedback

Air

HighResMIP High Resolution

Water

GMMIP Global Monsoons

ISMIP6 Ice Sheet

SIMIP Sea Ice

DynVar Dynamic Variability

FAFMIP Flux Anomaly Forced

OMIP Ocean

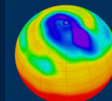


What is the data request?

*The data request is the composite of the **endorsed MIP** requests.*

(1) “DECK” is not an endorsed MIP ...

(2) The request from each MIP covers the data that they need from the experiments they define, from the DECK + CMIP6 historical, and from experiments defined by other MIPs where it is needed for the analysis they propose.



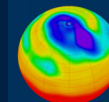


Endorsed MIPs .. request overview

Volume of data (Tier 1, Priority 1) requested by MIPs in left column from experiments defined by MIPs in top row.

	CMIP	AerChemMIP	C4MIP	CFMIP	DAMIP	DCPP	FAFMIP	GeoMIP	GMMIP	HighResMIP	ISMIP6	LS3MIP	LUMIP	OMIP	PMIP	RFMIP	ScenarioMIP	VolMIP	TOTAL	Unique	CALC
CMIP	27T																	27T	2.8T	Workings	
AerChemMIP	9.9T	15T													3G	622G		26T	20T	Workings	
C4MIP	2.3T		1.1T		71G		48G				253G	45G		69G		464G		4.3T	3.6T	Workings	
CFMIP	11T			3.5T														14T	13T	Workings	
DAMIP	6.4T				9.2T													15T	8.7T	Workings	
DCPP	108G					1.7T										1G		1.9T	1.7T	Workings	
FAFMIP	3.8T						622G											4.5T	3.5T	Workings	
GeoMIP	7.8T							2.8T										10T	2.6T	Workings	
GMMIP	47G								188G									235G	170G	Workings	
HighResMIP	48T									4.0T								52T	44T	Workings	
ISMIP6	544G										799G			36G		31G		1.4T	454G	Workings	
LS3MIP	264G											1.9T				1.3T		3.5T	3.3T	Workings	
LUMIP	421G		363G									99G	455G			441G		1.8T	871G	Workings	
OMIP	13T												1.9T					15T	1.9T	Workings	
PMIP	7.9T		339G											7.3T		417G		15T	9.8T	Workings	
RFMIP	6.5T														876G			7.4T	6.0T	Workings	
ScenarioMIP																				Workings	
VolMIP	6.5T																11T	17T	10T	Workings	
CORDEX	7.6T															6.9T		14T	4.9T	Workings	
DynVar	2.7T	4.6T								245G						980G	1.5T	10T	7.1T	Workings	
SIMIP	653G																	653G	338G	Workings	
VIACSAB	7.1T		420G	232G	2.2T	1.9T	141G	2.8T	131G	309G	1.3T	136G	301G	2.9T		10T		30T	17T	Workings	
ECMWF	1.8T	1.8T	1.8T	1.8T	10T	3.6T	761G	5.0T	302G	4.2T	1.7T	2.2T	677G	1.9T	9.5T	876G	17T	11T	194T	Workings	

area/tabs03/exnt | LUMIP | LS3MIP | 1 | 1.html





Managing duplicate requests

There is a single consolidated list of CMOR variables.

All endorsed MIP requests refer to the same set of variables.

The python API will provide a list of required variables for any combination of MIPs

